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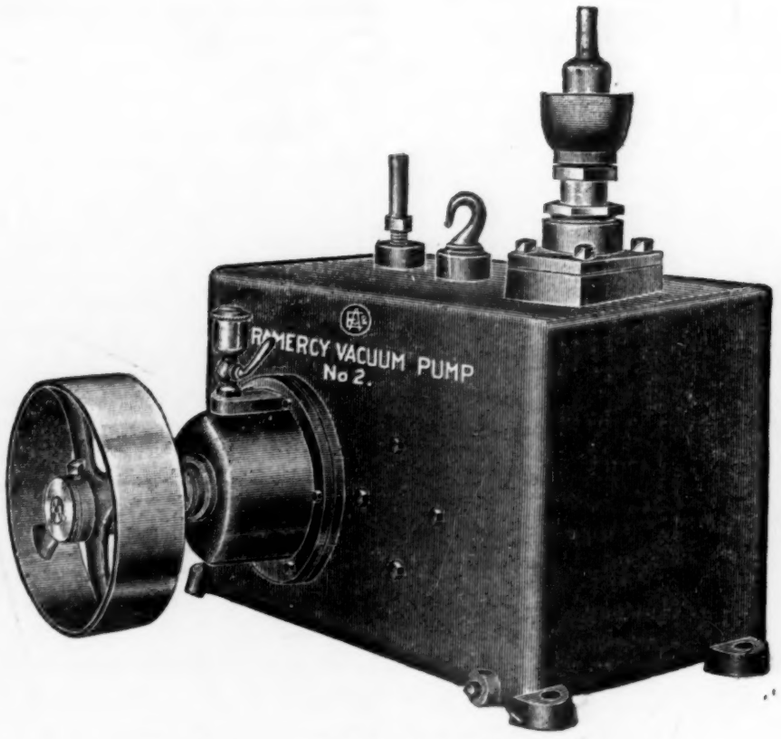

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SCIENCE

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THE BUILDING OF ATOMS AND THE NEW PERIODIC SYSTEM[1]

WHAT is usually known as the periodic system of the elements was developed largely in the decade from 1860 to 1870, during the period of our civil war, by de Chancourtois, Newlands, Mendeléeff and Meyer. Mendeléeff, the third to develop the system, has been given almost all of the credit for it, but this is largely because he paid very much more attention to its details than any of the three others. It has now been found that the Mendeléeff periodic relation is simply one method of expressing the arrangement in space of the electrons in the outer part of the various kinds of atoms.

Five years ago I discovered a *new periodic system of the elements, or more properly speaking, of the atoms. This second system is not at all directly related to the arrangement of the electrons in the outer part of the atom, but has been found to indicate how the atoms are built up, that is, it is related to the structure of the nuclei of the different species of atoms.*

In order to understand the meaning of this new periodic system it is important to have a good idea of the present theory as to the general structure of the atom. According to Rutherford the atom is similar to the solar system in that it has a central sun called the nucleus of the atom, and a system of planets, each of which consists of one negative electron. The atom as a whole is electrically neutral, and the electrons outside the nucleus, which we may call the planetary electrons, are held in the atom by a positive charge on the nucleus. This positive charge is equal numerically to the sum of the charges of all of the planetary electrons. This is often expressed

[1] Abstract of a general address presented at the Philadelphia meeting of the American Chemical Society, September 3, 1919.

by the statement that the number of positive charges on the nucleus is equal to the number of negative electrons, since it is known that the hydrogen ion carries a positive charge equal to the negative charge on the negative electron.

The atom is similar to the solar system in a second sense, for the planetary electrons are, relative to their size, about as far from each other and from the nucleus, as the planets and the sun. Thus it need not be surprising from this point of view, that Rutherford has found that the very minute nucleus of a helium atom, often called the alpha particle, may be shot directly through many thousands of other atoms, without hitting a single nucleus or a single negative electron, just as a planet like the earth might be shot through thousands of solar systems like our own without hitting a single sun or planet.

The atom is like the solar system too, in that the nucleus, like the sun, possesses nearly the entire mass of the system, since in general the nucleus is more than two thousand times heavier than all of the electrons which surround it. While the atom is so small that a row of fifty million atoms would be only about one inch long, if they were put as closely together as they are in solids; and so small too, that there are 180 thousand billion billion atoms of carbon in one cubic centimeter of diamond; the atom is so *large* compared with the electron, that, if we take the dimensions usually accepted for the electron, there would be space in a single atom sufficient to contain ten million billion electrons, while the atom which contains the greatest number of planetary electrons, uranium, actually has only 92 of these. According to the work of Rutherford, Geiger, Darwin and Marsden, the nucleus of even the heaviest atom, is not very much larger than a negative electron. Thus the atom may be said to be very sparsely populated with electrons.

The atom is *unlike* the solar system in that the planetary electrons are arranged more or less symmetrically in space around the nucleus, at least that is the idea expressed in papers by the American chemists, Parsons, Harkins, Lewis and Langmuir, the last two having paid the most attention to the details of the arrangement. Also, while the solar system is held together by the gravitational attraction between the large mass in the sun and the smaller masses in the planets, the atoms are held together by the positive electrical charges in the nucleus and the negative charges of the electrons, together with whatever magnetic effects are produced by the rotation of the electrons.

THE BUILDING OF ATOMS

While chemists have not as yet synthesized any atoms, it is also true that they have only recently begun the study of their structure. Now, when a chemist wishes to build up even such a simple thing as an organic molecule, he first studies its structure, and often many years intervene between the working out of the structure of the molecule and its first synthesis. In the synthesis of an organic dye there may be two steps which we may have to consider. Suppose for example that the first of these consists of a complex set of reactions which are very difficult to carry out, while the second step will occur by itself if the intermediate product is only left standing in the air. It is evident that the practical chemist will need to put almost his whole attention on the first step of the synthesis. The building of atoms is similar in that the first step, the building of the nucleus of an atom, has not yet been accomplished, while, if the nucleus were once built, it would of itself pick up the whole system of planetary electrons which would turn it into a complete atom. For example in the disintegration of the nuclei of certain radioactive atoms, alpha particles which are the nuclei of helium atoms, are shot out as rapidly as twenty thousand miles per second, so rapidly that they pass through as many as *half a million* other atoms before coming to comparative rest. Now Rutherford has proved that when these nuclei finally slow down, they give the ordinary spectrum of helium, which indicates that each alpha particle has picked up the two negative electrons which are essential to convert it into a complete helium atom.

THE BUILDING OF THE NUCLEI OF COMPLEX ATOMS

Suppose that we consider the specific problem of the building of a carbon atom. The characteristic chemical and physical behavior of carbon are due to its six planetary negative electrons, and these will arrange themselves around any nucleus which carries a positive charge of six, so our problem reduces to that of putting six positive charges of electricity into the extremely minute space occupied by the nucleus of an atom, with a diameter of the order of 10^{-12} cm., that is one millionth of a millionth of a centimeter. These six positive charges must not only be put into this *ultra-ultra-microscopic* space, but must unite to form an intra-nuclear compound of extreme stability.

Now, up to the present time, the smallest mass ever found associated with one positive electrical charge, is that of the hydrogen ion, which is associated primarily with the mass of the hydrogen nucleus, with a value of 1.0078.[2] If six of these hydrogen nuclei could be packed tightly enough together to form the nucleus of a new atom they would form the nucleus of a carbon atom, which would have a mass of approximately six. That no carbon atom of this mass exists, is not because such a nucleus if formed, would not give a true carbon atom, but because six positive hydrogen nuclei undoubtedly repel each other, and can not be made to form a stable system.

In order to make a complex nucleus stable it is necessary to include not only hydrogen nuclei, but also negative electrons. Since the mass of the ordinary carbon atom is 12.00, it could be built up from 12 hydrogen nuclei, bound together by six negative electrons. Such a nucleus would have a positive charge of 6, it would therefore take up six negative electrons, and would thus form a complete carbon atom. The only objection to this idea is that 12 times 1.0078 is 12.036, while the weight, and probably the mass, of the carbon atom is only 12.005, or the actual carbon atom is 0.76 per cent. lighter than it should be if built from 12 hydrogen nuclei without any resulting change of mass. Now Professor A. C. Lunn has worked out the mathematical expression for this effect for the writer, and this shows that according to the electromagnetic theory, if such a nucleus is held together in a very small space by attractive forces there *should* be a loss of mass in its formation, and that in a simple atom the observed loss of mass would result if the center of the negative electron has a distance 400 times the radius of the positive electron.

The alpha particle, or the nucleus of a helium atom, carries two positive charges, has a mass of four, and is probably made up of four positive hydrogen nuclei bound together by two negative electrons into what is probably by far the most stable nucleus of any known atom, except that of hydrogen itself.

If we make the atomic number of the element equal to the positive charge on the nucleus, then the atomic number of hydrogen would be one, that of helium two, that of carbon six, of lead eighty-two, and of uranium, ninety-two. Now the mass of the carbon atom (atomic number 6) is exactly what it should be if its nucleus consists of 3 alpha particles. Also, 3 times the charge on the alpha particle is just the charge on the carbon nucleus. It is easily seen that there is a possibility that the carbon nucleus is simply a compound made up of 3 alpha particles, of a formula 3 α. Now it is obvious that if the nuclei of complex atoms were simply structures built up from alpha particles, that, since the positive charge on the alpha particle is two, there would be no nuclei with an odd number of charges. The work of Mosely indicates, however, that the elements of odd atomic number also exist, but it is certain that the nuclei of such odd numbered atoms can not be compounds made of alpha particles alone.

On the other hand, it is quite evident, as I announced four years ago, that the nuclei of the atoms of even atomic number are mostly intra-nuclear compounds of helium nuclei. For this there is much evidence which will be found in my printed papers in the *Journal* of the American Chemical Society and in Science. This evidence can only be hinted at here, since the time for the paper is short,

[2] Equal to 1.66×10^{-24} grams.

TABLE I

The Helium—H_3 System of Atomic Structure H = 1.0078
He = (4 H) = 4.00

	1	2	3	4	5	6	7	0	8	
At. No...	3	4	5	6	7	8	9	10		
	Li	Be	B	C	N	O	F	Ne		
Ser. 2 ...	$He+H_3$	2He+H	$2He+H_3$	3He	$3He+H_2$	4He	$4He+H_3$	5He		
Theor....	7.00	9.0	11.0	12.00	14.00	16.00	19.00	20.0		
Det.....	6.94	9.1	11.0	12.00	14.01	16.00	19.00	20.0		
At. No...	11	12	13	14	15	16	17	18		
	Na	Mg	Al	Si	P	S	Cl	A		
Ser. 3 ...	$5He+H_3$	6He	$6He+H_3$	7He	$7He+H_3$	8He	$8He+H_3$	10He		
Theor....	23.0	24.00	27.0	28.0	31.00	32.00	35.00	40.0		
Det.....	23.0	24.32	27.1	28.3	31.02	32.07	35.46	39.9		
At. No...	19	20	21	22	23	24	25		26	27
	K	Ca	Sc	Ti	V	Cr	Mn		Fe	Co
Ser. 4 ...	$9He+H_3$	10He	11He	12He	$12He+H_3$	13He	$13He+H_3$		14He	$14He+H_3$
Theor....	39.00	40.00	44.0	48.0	51.0	52.0	55.00		56.00	59.00
Det.....	39.10	40.07	44.1	48.1	51.0	52.0	54.93		55.84	58.97

Increment from Series 2 to Series 3 = 4He. Increment from Series 3 to Series 4 = 5 He (4 He for K and Ca). Increment from Series 4 to Series 5 = 6He.

Note: The simple helium system begins with carbon (= 3 He), and continues with oxygen (4 He), neon (5 He), magnesium (6 He), silicon (7 He), sulphur (8 He), argon (10 He), calcium (10 He), titanium (12 He), chromium (13 and iron (14 He).

While both the argon and the calcium atom are built from 10 helium atoms, the nucleus of the argon atom contains 10 alpha (α) particles alone, while the nucleus of the calcium atom contains 10 alpha particles with two negative electrons which serve to bind on one of the alpha particles. These may be called binding electrons.

The composition of the thorium nucleus is expressed by the formula $\alpha_{58}e_{26}$, that of the nucleus of the uranium atom by $\alpha_{58}h_2e_{26}$, and that of the isotope of lead which comes from radium as $\alpha_{81}h_2e_{32}$.

and I wish to show just a little as to the way in which these alpha particles are bound together.

First, the atomic weights of the lighter atoms of *even* atomic number beginning with carbon are, 12, 16, 20, 24, 28, 32, 40, 40, 48, 52 and 56, the last being the atomic weight of iron, of atomic number 26. Thus the atomic weights of the atoms whose nuclear charge is expressed by an even number, are divisible by 4, the weight of the helium nucleus. If we study the elements of high atomic number, beginning with uranium, which is number 92, we find that the even numbered atoms change into the atom of next lower even number by the loss of a single alpha particle from the nucleus of the atom. Thus we find just the same system of structure indicated by the actual disintegration of the radioactive atoms, as is made evident by the atomic weights and the nuclear charges on the atoms of low atomic weight.

Second, the atomic weights of the elements of odd atomic number point to the idea that their nuclei are compounds of a certain number of alpha particles with three hydrogen nuclei, so that their formula is $n\alpha + 3h$ In the exceptional cases of nitrogen the formula is $3\alpha + 2h + \epsilon$.

Four years ago I presented the following formula for the respective nuclei:

Carbon nucleus $= 3\alpha$
Nitrogen nucleus $= 3\alpha + 2h + \epsilon$
Oxygen nucleus $= 4\alpha$

where ϵ represents a negative electron.

It is of extreme interest in this connection to note that Sir Ernest Rutherford has just announced that he has been able to bombard these atoms with extremely rapid moving alpha particles, and that he has been

able to drive hydrogen out of nitrogen atoms, but not out of either carbon or oxygen.

THE NEW PERIODIC SYSTEM OF THE ATOMIC NUCLEI

The *ordinary* periodic system, when put in a graphic form, as has been done by Crookes and more correctly by Soddy, and by Harkins and Hall, is a graphic expression of the arrangement of the planetary electrons. The *new* periodic system of the atomic nuclei was discovered by me five years ago in the following way. I reasoned that if the nuclei of the even numbered atoms are built of helium nuclei alone, while those of odd atomic number contain hydrogen nuclei in addition, that there should be a considerable difference in stability between the two classes of nuclei. I also told my students, before making any further study, that the even numbered atoms would prove to be more stable than the odd numbered.

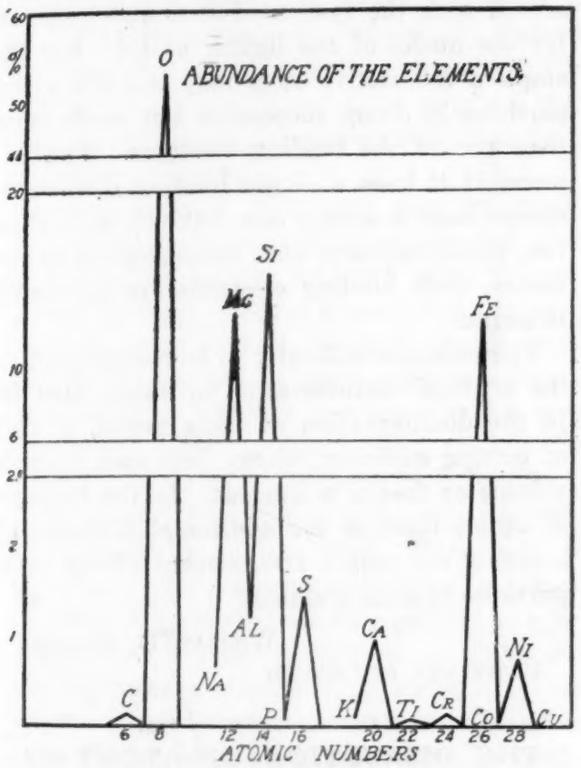

FIG. 1. The Periodic Variation in the Abundance of the Elements as the result of Atomic Evolution. The data are given for 350 stone and 10 iron meteorites, but the relations are true for meteorites in general. Note that *ten* elements of even atomic number makes up 97.59 per cent. of the meteorites, and *seven* odd-numbered elements, 2.41 per cent., or 100 per cent. in all. Elements of atomic number greater than 29 are present only in traces.

Now there is, unfortunately, no known method of testing directly the stability of the lighter atoms, but it seemed a reasonable hypothesis that if the atomic nuclei had ever been built up, that in general the most stable nuclei would be formed in the greatest abundance. An investigation brought forth the following facts:

1. The *atoms of the even numbered or helium series* are *127 times more abundant* in the iron meteorites than the atoms of the helium-hydrogen or odd numbered series.

2. In the stone meteorites they are 47 times more abundant.

3. In the surface of the earth the even numbered atoms are about 10 times more abundant than the odd numbered.

4. The even numbered rare earth elements are much more abundant than the odd numbered.

5. In the meteorites every even numbered element is much more abundant than the two adjacent odd numbered elements.

6. All of the seven most abundant elements in the meteorites are even numbered, and these seven elements alone make up 98.6 per cent. of all of the material of the meteorites.

Thus the periodicity of this system is from even to odd, or the periods are two atomic species in length, while in the Mendeléeff system the periods are 2, 8, 18, and 32 elements in length. Dr. Norris F. Hall, of Harvard University, has pointed out that both the isotopic complexity and the number of predominant radiators in a pleiad, follow just this periodic variation.

THE STABILITY OF THE NUCLEI OF ATOMS

The most stable nuclei seem to be those of oxygen, magnesium, silicon, iron, all of them even numbered elements of low atomic number (except that as has been stated the helium nucleus is probably extremely more stable than any of these).

The atoms whose nuclei carry 28 or less positive charges are much more stable than those of higher atomic number. This is illustrated by the relative abundance of such elements as represented by the following table:

TABLE II

Proportion in Various Materials of the Elements of Low Atomic Numbers

Material	Percentage of Elements with Atomic Numbers 1–29	30–92
Meteorites as a whole	99.99	0.01
Stone meteorites	99.98	0.01
Iron meteorites	100.00	0.0
Igneous rocks	99.85	0.15
Shale	99.95	0.05
Sandstone	99.95	0.15
Lithosphere	99.85	0.15

When there are several varieties of atomic nuclei all carrying the same positive charge, as is the case with lead, with 82 positive charges on the nucleus, the nuclei differ in stability, but the complete atoms do not differ in their chemical properties nor in their spectrum. This has been shown very beautifully by Soddy, by Merton, and by Richards and Baxter, but most accurately by Dr. Aronberg, who worked at my suggestion. Two isotopes may have practically the same atomic weights, and differ only in the stability of their nuclei, as I pointed out four years ago.

THE BUILDING OF ATOM NUCLEI AGAIN

Let us now pay attention to the building of nuclei of even numbered charge, since the time is not sufficient to consider those of odd number also. Three, four, five, six, seven, eight or ten alpha particles may unite to form the nucleus of a complex atom, but two alpha particles alone, or more than ten alone, do not make a stable system.

In all heavier atoms there are some alpha particles which are bound on by two negative electrons. Thus the sulphur nucleus is a compound of 8 alpha particles alone, while the argon nucleus contains 10 alpha particles and two negative binding electrons. It is the presence of an extra alpha particle in the argon nucleus which makes its atomic weight higher than that of potassium.

The number of binding electrons does not increase to 4 until element 32 (germanium) is reached, but rises to 26 in the thorium atom. *It is these binding electrons which are given off in the beta disintegrations of the radioactive elements,* and if time permitted it could be shown that this disintegration is exactly in accord with the system of structure proposed for the nuclei of the lighter atoms. For example a radioactive atom may lose five alpha particles in direct succession, but never more than two of the binding electrons. Furthermore, if it loses a single binding electron it always loses a second one, but not more than two, which indicates that, corresponding to our theory, such binding electrons are associated in pairs.

The principal difficulty to be encountered in the artificial disintegration of atoms, that is, in the disintegration of their nuclei, is that of getting sufficient energy into such a small volume as that of a nucleus. In the building of atoms there is the additional difficulty of securing the proper arrangement of the alpha particles to give stability.[3]

William D. Harkins
University of Chicago

THE DISRUPTION OF ATOMS BY ALPHA RAYS

Recently under the modest title "An Anomalous Effect in Nitrogen,"[1] Rutherford reported the remarkable discovery that when nitrogen molecules are bombarded by alpha rays, penetrating rays with a range of 28 cm. in air are produced which are certainly lighter than nitrogen atoms and which are probably

[3] The details of the system of atom building presented here may be found in the following references: *Journal of the American Chemical Society,* 37, 1367–1421, 1915, 38, 186–214, 1916, 39, 856–879, 1917; 41, 970–992, 1919. *Phil. Mag.,* 30, 723–734, 1915. Science, N. S., 46, 419–427, 443–448, 1917. *Proc. National Academy of Sciences,* 1, 276, 1915; 2, 216–224, 1916.

[1] *Phil. Mag.,* 37, 581–87, June, 1919; *cf.* Science, 50, 472, November 21, 1919.

hydrogen rays. His experiments furnish conclusive evidence that by this bombardment, nitrogen atoms may be disrupted and thus transformed or transmuted.

In the paper preceding the one just mentioned, Rutherford describes other secondary rays produced by alpha ray bombardment in both nitrogen and oxygen, which have a range in air of 9 cm. instead of 28 cm. These rays, he states, are presumably swift, singly charged nitrogen and oxygen atoms, respectively. The purpose of this note is merely to point out that their nature may be more interesting than their discoverer suggests.

The conclusion that they may be singly charged atomic rays is based on the fact that the computed ranges for such rays, 9.3 cm. the same as the observed ranges, 9 cm. in each case, whereas doubly charged atomic rays would be expected to have only one fourth these ranges. But the agreement is not very convincing, and there are other reasons for doubting the correctness of the hypothesis.

The alpha-ray experiments practically force us to accept the nuclear atom. In the case of such an atom, is it possible that a singly charged nitrogen ray may be produced as a result of a close collision between an alpha ray and a nitrogen nucleus? I think not; for since a singly charged nitrogen atom is a nucleus with six orbit electrons attached, a singly charged nitrogen ray could be produced only if each of the electrons as well as the nucleus were acted upon by the relatively large force required to give it a speed of about 10^9 cm./sec. in less than 10^{-13} sec. It can easily be computed that the field of the nucleus is insufficient to hold the electrons under these circumstances. Therefore, unless we postulate a stability which ionization phenomena seem to disprove, we must conclude that after such collisions, the orbit electrons are left behind. Moreover, even if singly charged rays were shot out, it is difficult to believe that most of the orbit electrons would not soon be detached as a result of the passage of the rays through many atoms. In other words, various experiments have given us a conception of the structure of atoms which makes it highly improbable that singly charged nitrogen rays would be produced as a result of bombardment by alpha rays.

Now the secondary nitrogen rays can not be multiply charged nitrogen atoms or nuclei, for such rays would have too short a range. And they can not be hydrogen rays because the scintillations they produce are too bright. Therefore they must be fragments of nitrogen nuclei which are larger than hydrogen nuclei. Rutherford has proved, as stated above, that nitrogen nuclei can be disrupted by alpha rays. If we suppose, as seems probable, that the nitrogen nucleus is made up of hydrogen and helium nuclei, then the disruption of the nucleus would be expected to result in both hydrogen and helium rays. It is therefore possible that *the less penetrating secondary rays observed by Rutherford when nitrogen is bombarded are alpha rays produced by the disruption of nitrogen nuclei.* The similar rays observed with oxygen may also be secondary alpha rays originating in disrupted oxygen nuclei. The fact that the scintillations produced by these rays are much like those due to alpha rays of the same range supports this suggestion.

But how is it possible for the range of the secondary alpha rays to be greater than that of the primary rays, in violation of the laws of mechanics? Just as the energy of alpha rays comes from the potential energy released when a radioactive atom becomes unstable, so the rays resulting from the disruption of a nitrogen nucleus may be expected to receive energy as a result of the mutual repulsion of the fragments. If the secondary rays are alpha rays, then, the effect of the bombarding alpha rays must be to make the nuclei unstable, producing an *artificial radioactivity.*

It is believed that the difficulty of explaining why so many of the secondary rays travel in the direction of the bombarding rays is no greater from this point of view than from the other.

It will be extremely interesting to determine by deflection methods the mass and charge of these rays so as to decide whether they are in fact nuclear fragments. In this way we may

get definite evidence as to the fundamental structure of nuclei.

G. S. Fulcher
National Research Council,
November 27, 1919

THE FESTSCHRIFT OF SVANTE ARRHENIUS[1]

Highly Honored Friend and Master:

Modern culture is perhaps best characterized by man's enlarging control over nature. But this has not been attained without an increased knowledge of the forces wherewith nature works. Through your now over thirty year old theory concerning force ions, you have made possible a deeper penetration into nature's own workshop than was formerly attainable. Concerning electrolytic phenomena, which your countryman Berzelius, with correct appreciation of their fundamental significance, so diligently studied, you have shed a wonderful light and you have thereby strengthened the foundations for the whole chemical knowledge and this not alone with respect to lifeless nature, but in equally high degree with respect to living nature. "Selten hat ein glücklicher Gedanke," once said W. Ostwald, who was himself the first to understand its meaning, "in so hohem Maasse Licht über weite und schwierige Gebiete geworfen, wie die von Arrhenius entwickelte Idee, dass die Elektrolyte in wässriger Lösung in ihre Ionen dissoziirt sind."

Briefly stated, you have with your theory stirred up a culture wave within the scientific and technical world which will sweep forward through time and thereby you have also become one of our time's culture bearers.

If one may believe Xenophon, Socrates used to advise those who sought help concerning their difficulties, to carry out that which they knew should happen, as he deemed best; but otherwise he advised that they ought to have recourse to the art of divination, hearken to the inner spirit, which should give them directions. Thus does also the scientist. When theory is clear he follows it in the best manner, but when the opposite is true, even he must resort to divination; and a wonderful prophet you have been. You seem once to have had one of these dreams which, as is said, sometimes goes ahead and anticipates the judgment of clear daylight.

Among the friends of Socrates was also Aristippus. It is related concerning him that he like the rest of beauty-loving Athens was sorely smitten by the handsome Lais. One of his friends expressed surprise over this that even he, the sober philosopher, should have been caught in her net. Aristippus, who was no friend of superfluous words, answered merely: Caught, by no means imprisoned. Thus you can also say concerning the ions. You have bound them to reality by unbreakable bonds, but your spirit for research has not let itself be bound to merely this field of labor.

When one wishes to scale the Alps he comes first to the warm, peaceful valleys where living nature steps forward to meet him in all her beauty, and there one might wish to dwell his whole life were not the view so limited. One climbs higher and higher and the horizon widens, but the air becomes sharper, flowers and foliage disappear, and at last one is met by only the cold blasts of snow and ice. Everything would speak of death if in this indescribable silence, in this boundless heaven there was not found something which spoke of the unending, the everlasting. A similar road you have trodden through the research world. You have with your keen vision imagined yourself to see the whole universe's unending space and everlasting time, how the worlds therein develop and dissolve, how all is a *perpetuum mobile;* yes, you have with the camera's help found how the seeds of life sail through the ether ocean from world to world. Such are the wide-embracing views you have given us.

To celebrate the day when you with yet unbroken power and undiminished interest enter upon your seventh decennium, we have with admiration for your research work and in devoted friendship for your person dedicated to you this writing.

[1] Translation of Preface of "Festskrift utgiven Till Svante Arrhenius' 60-Arsdag den 19 Februari, 1919."

THE DEATH OF LADY ALLARDYCE

THE name of Constance Allardyce, wife of Sir William Allardyce, governor of the Bahama Islands, will not go unrecorded in the annals of science. Before appointment to the Bahamas and after eight years of diplomatic service in the Fiji Islands, Sir William Allardyce was governor of the Falkland Islands and it was during their eleven years on this station that Mrs. Allardyce (as she then was) showed her helpful interest in scientific undertakings. The writer gratefully recalls her enthusiastic aid in assembling the fossils of the rich and remarkable Devonian fauna of the islands when there was no one else to help and where there was no notion of what was wanted. Responding to an appeal for aid made to the governor, she took up the search, diligently acquainted herself with what was to be looked for, aroused the curiosity and interest of the people of the nearer and farther islands even to the shepherds scattered over those seventy-five bits of archipelago, established collecting stations here and there among them and so brought together scientific material of great worth. She kept alive this interest during the years of her residence, extended it into other lines and eventually established the Falkland Islands Museum at Stanley, the southernmost museum of the world and probably the most remote scientific outpost of the British Empire. It may be well said that the collections gathered by Mrs. Allardyce are the basis of pretty much all that we know to-day of the ancient life of those islands and her name and services have been permanently interwoven in the geological story of the Falkland Islands.

JOHN M. CLARKE

SCIENTIFIC EVENTS

GIFT TO THE MUSEUM OF VERTEBRATE ZOOLOGY OF THE UNIVERSITY OF CALIFORNIA

Two hundred thousand dollars have been given by Miss Annie M. Alexander to the University of California for the permanent support of the California Museum of Vertebrate Zoology. Dr. Joseph Grinnell, associate professor of zoology and director of the museum makes the following statement:

> The work of the California Museum of Vertebrate Zoology was formally inaugurated on March 23, 1908, when Miss Annie M. Alexander, then of Oakland, upon her own initiative entered into an agreement with the university by which she promised support for a period of seven years. It has now been nearly twelve years since the museum was thus founded by Miss Alexander, and she has continued her support in increasing measure, until now, by her endowment, the continuance of the museum is insured for all time.
>
> The collections of the museum comprise at the present time a total of 70,833 specimens, consisting of 30,519 mammals, 31,347 birds, 1,804 birds' nests and eggs, 7,163 reptiles and amphibians. In addition there are some 17,000 privately owned specimens in the various groups, on deposit here. All of this material is freely available for study by any responsible natural history student, here and elsewhere. A system of loaning is in operation by which series of specimens are sent to any investigator wherever he may be located. The value of the museum's possessions in the way of specimens and facts can not help but increase in direct ratio to the extent in which these are used. The free loaning of material in vogue does away with any grounds for the complaint sometimes made against museums, that they are merely "cold storage" institutions whose aims are only to gather and hoard. A total of 9,713 specimens has been loaned, during the past eleven years, to 128 different institutions or individuals. Investigators in Washington City alone have had sent to them for examination 2,642 of the museum's mammals and birds.

The staff of the museum at the present time consists of Dr. Joseph Grinnell, director; Harry S. Swarth, curator of birds; J. Eugene Law, curator in osteology; Tracy I. Storer, field naturalist; Joseph Dixon, economic mammalogist; Harold C. Bryant, economic ornithologist; Margaret W. Wythe, general assistant, and Richard Hunt, assistant curator of birds.

LOSS OF GEOLOGISTS BY THE NATIONAL SURVEY

IN his annual report the director of the United States Geological Survey writes:

The fact that there have been 77 resignations from the scientific force of the United States Geological Survey, Department of the Interior, during the last year—17 per cent. of the force—suggests inadequacy of compensation, and the percentage of resignations in the clerical and non-scientific force was even larger. This statement of course does not include separations to enter military service. The largest inroad upon the Geological Survey efficiency comes from the oil companies; the final result of the pioneer work of the federal geologists in applying geologic methods to the search of oil and gas is that a large proportion of the leading oil geologists the world over are United States Geological Survey graduates. Indeed, the future decline in popularity of the Geological Survey as a recruiting station for oil-company personnel will be due simply to the fact that the experienced oil geologists who remain in the government service are from personal preference immune to outside offers.

The relations between government salaries and outside salaries of geologists has been definitely determined in a compilation of the records of 29 geologists who left government service after receiving an average salary of $2,271. The average initial salary of these men in private employ was $5,121, and after about two years of average service this compensation averaged $7,804, and eight of these geologists receive $10,000 or more. The disparity is even greater if consideration is given to the large financial returns from investments made by the private geologists in connection with their professional work, a privilege properly denied by statute to the official geologist.

That the value of these men as specialists and consulting geologists is far greater to the country at large than to private corporations is undeniable. Furthermore, it is important to note that most of these geologists had persisted to the limit of endurance with a magnificent spirit based on their love of scientific research and their desire to contribute to the sum of geologic knowledge. Most of them have been forced out of the service by sheer financial necessity. Unless adequate measures are taken to ameliorate the situation, the geologic staff is destined to suffer far greater deterioration of morale and depletion in its ablest, most responsible, most experienced and most valuable members. The Geological Survey is passing into a stage when, with greater need than ever for systematic geologic work in the country, it is ceasing to be attractive to the young men of greatest ability, training and promise. This situation deserves prompt and effective remedy, for it threatens most seriously to cripple this branch of the public service.

REDUCED RAILWAY FARES TO MEETINGS OF SCIENTIFIC AND LEARNED SOCIETIES

Mr. Frederic S. Hazard, assistant secretary of the American Association for the Advancement of Science, and representatives of the American Historical Association and other societies meeting at Cleveland have been in correspondence with the U. S. Railway Administration in regard to reduced fares which have not been granted. In their letter they say:

> We respectfully submit that this narrow interpretation of the term "educational" constitutes a discrimination against the learned and scientific societies of the country which is prejudicial not only to their interests but to the general cause of education in America viewed in any comprehensive way.
>
> It is well known that these societies are not in any sense political, commercial or money-making, but are solely scientific and educational. Their membership, especially that part of it which usually attends their meetings, is largely composed of teachers in universities, colleges and the public schools and of men and women engaged in scientific research. To these members the benefit derived from annual contact with their colleagues is of no small importance, and is reflected in their work in the classroom or laboratory. To the public-school teachers the meetings afford almost the only opportunity of coming into close touch with the leading specialists and advanced teachers in their respective fields. It is impossible to overestimate the advantage to the educational system of the country that has come from these annual gatherings of teachers and investigators; from the point of view of content it is certainly as important as is, from the point of view of method and administration the advantage that has been gained from the meetings of the purely pedagogical societies.
>
> But it should be emphasized that the scientific societies have always laid stress upon the pedagogical aspects of their work. They constantly provide in their meetings for special sessions devoted to the teaching of their various disciplines. Some of them have long maintained standing committees on teaching, and have published reports which have been adopted throughout the country as the basis

of school work in the respective subject. Furthermore, these societies have frequently been recognized as of public utility by the government. The Department of Agriculture, for example, grants special leave to its employees in order that they may attend the meetings of the American Association for the Advancement of Science. The War Department, to cite another instance, has detailed officers to attend the meetings of the American Historical Association and of the American Association for the Advancement of Science.

The assistant director of railroads writes:

In view of the arguments presented by you for favorable action it seems appropriate to set before you the considerations that prompted the government to grant reduced rates for conventions. It was a very serious question whether the government would be justified in putting them into effect at all. Past experience has shown that as a whole such reduced fares have operated to reduce railroad revenues and to increase the cost of transportation because the giving of them encouraged people who were planning to make business trips to adjust their trips so as to take advantage of the reduction. This resulted in diminishing the amount of travel, and consequently increasing its cost, prior to the time such reduced fares were put into effect, and in congesting the travel during the time such reduced fares were in effect, thereby increasing the cost during that period also. In the present time, when railroad costs just as all other industrial costs are exceedingly high, it seemed clear that the government would not be justified in putting into effect reduced rates which would result in an important diminution in the net earnings received from the business. On the other hand, it was deemed desirable to encourage the attendance at certain conventions and to afford to persons who wished to attend them and who would be unable to go except for reduced rates the opportunity to do so. The classes of conventions decided upon were religious, charitable, fraternal, military and educational. This classification was adopted with a full realization of the difficulties which would result and that the action might be considered an arbitrary one. It was felt, however, that it was based upon sound grounds and, under all the circumstances, is consistent and defensible. It was plain that the term "educational" taken in its broad sense could be construed to cover a very large number of conventions. For example, those of doctors, lawyers, dentists, business colleges, etc. It was, therefore, necessary to restrict its definition, and this was done by confining it to those conventions having to do with elementary education, such as meetings of school teachers, and among these meetings was included the National Educational Association.

THE ST. LOUIS MEETINGS OF THE AMERICAN ASSOCIATION FOR THE ADVANCEMENT OF SCIENCE

THE announcement sent out from the office of the permanent secretary of the American Association for the Advancement of Science says:

The American Association for the Advancement of Science and many national scientific societies affiliated with it will hold its seventy-second meeting in St Louis, from December 29, 1919, to January 3, 1920, under the auspices of the educational institutions of the city. All meetings will be held in the Soldan High School, corner Union Boulevard and Kensington Avenue. Dr. Simon Flexner, of the Rockefeller Institute for Medical Research, will preside. The address of the retiring president will be given by Dr. John Merle Coulter, of the University of Chicago, at the opening general session of the association, and will be followed by an informal reception to members of the association and of the affiliated societies.

This seventy-second meeting of the American Association, which was established in 1848, will be marked by the importance of its program and by the increased interest manifested in all branches of the natural and the applied sciences. It will embrace a program devoted very largely to definite working problems of reconstruction. When the association last met in St. Louis, fifteen years ago, the membership of the association was only 4,000. The membership of the association at present numbers nearly 15,000 and the coming meeting will be one of the most important gatherings of scientific men hitherto held in this country or elsewhere.

The occasion should be taken to strengthen the association and its work in the central states, which have in recent years assumed such leadership in scientific research. We may be sure that the scientific men of Washington University and the city of St. Louis will do their part. It would be well if the meetings might be celebrated by affiliation with the association of the strong state and city academies of the central states and the organization of a central branch of the association on the lines that have proved so successful on the Pacific coast.

SCIENTIFIC NOTES AND NEWS

The annual meeting of the New York Academy of Sciences was held on Monday evening, December 15, at which the following officers were elected. *President,* Dr. Edward L. Thorndike; *Vice-presidents,* Dr. C. L. Bristol, Dr. Isaiah Bowman, Dr. W. J. Giles, Dr. R. S. Woodworth; *Recording Secretary,* Dr. R. W. Tower; *Corresponding Secretary,* Dr. Henry E. Crampton, *Treasurer,* Mr. John Tatlock. The retiring President Dr. Ernest E. Smith delivered an address on "Applied Science and the War," after which two interesting and illustrated talks were given by Professor Douglas W. Johnson on "A Geographer at the Front and at the Peace Conference" and Professor Henry E. Crampton on "Tahiti and the South Seas."

The president of Northwestern University at Evanston, Ill., and the board of control of the Michigan College of Mines at Houghton, Mich., have each received from the chief of the Bureau of Ordnance of the U. S. Navy a formal letter of appreciation thanking them for permitting the time and experience of Dr. John F. Hayford, director of the College of Engineering at the former institution, and of Dr. F. W. McNair, president of the College of Mines, to be devoted to the service of the government and in particular to problems of naval gunnery. They were on the staff of the U. S. Bureau of Standards during the war and with Dr. Lyman J. Briggs, chief of the wind tunnel at that bureau worked on problems concerning the large guns of the navy. For purposes of test and demonstration they accompanied the Pacific Fleet on its recent voyage from Hampton Roads to the California coast, attached to the U. S. S. *Mississippi.* The letter of the chief of the Bureau of Ordnance states that the work of these scientific men has resulted in a considerable advance in the gunnery of the U. S. Navy.

The gold medal of the Society for the Protection of Wild Life has been presented to Dr. John M. Clarke, New York state geologist and director of the State Museum at Albany.

At its meeting held December 10, 1919, the Rumford Committee of the American Academy of Arts and Sciences appropriated the sum of three hundred dollars to Dr. Frederick G. Keyes, of the Massachusetts Institute of Technology, in aid of his research on the heats of neutralization at different temperatures.

Sir Donald MacAlister, president of the British General Medical Council, has been invested by President Poincaré with the Cross of Commander of the Legion of Honour.

The University of Leeds has conferred the following honorary degrees: D.Sc.: Admiral Sir Henry Jackson, First Sea Lord, 1915–1916; Surgeon-General Sir Alfred Keogh; Sir Almroth Wright; Professor W H.. Bragg, and Mr. J. G. Baker.

Dr. J. E. Stead has been nominated by the council of the British Iron and Steel Institute as president for next year in succession to Mr. Eugene Schneider.

W. F. Rudd, of the department of chemistry at the Medical College of Virginia, has been elected president of the American Conference of Pharmaceutical Faculties.

Mr. H. A. Nelson, formerly of the Bureau of Standards, is now with the New Jersey Zinc Company.

Dr. N. F. Drake, head of the departments of geology and mining engineering at the University of Arkansas, will sail on December 25 from Vancouver for China, where he will do research work until April of 1920.

Professor W. A. Noyes, of the University of Illinois, delivered an address on a "Career in Research" at the fiftieth meeting of the Medical Research Club of the Universtiy of Illinois held on December 9."

Dr. G. F. Loughlin, of the Geological Survey, is giving a course lecture on metalliferous geology at the Massachusetts Institute of Technology, temporarily filling the place of Professor Waldemar

The Thomas Vicary Lecture of the Royal College of Surgeons of England was delivered by Sir John Tweedy on December 3, on "The surgical tradition." The Bradshaw Lecture before the same College was delivered by Sir

Charles A. Ballance, on December 11 on "The surgery of the heart."

AT a meeting of the Royal Aeronautical Society at the Royal Society of Arts, on November 10, Dr. C. A. Swan gave a lecture on some physical and psychical effects of altitude.

ACCORDING to the Madrid correspondent of the London *Times* an International Conference of the Mediterranean has been held in that city. The principal object of the conference was to discuss the organization of a permanent central office of fisheries to be opened at Monaco. This office will be formed of delegates from each Mediterranean nation, and will allot and centralize the fisheries research work to be undertaken in the spring and autumn campaign, lasting from April 1 to May 31 and from October 1 to November 30 of each year, by the countries interested. The results of the work done will be published by the central office in a bulletin printed in the French, Spanish, Italian and English languages. Four ships will be at the disposal of the central office, the *Hirondelle II.* belonging to the Prince of Monaco, the specially built Italian ship *Tremitti,* and a French and a Spanish ship not yet detailed. The central office will coordinate the work hitherto carried out by each nation separately, with a view to developing the fishing industry by the scientific investigation of the habits of edible fishes, their migration and spawning periods. The central office will also coordinate the work of exploring the bottom of the Mediterranean and the study of its surface and under currents, about which very little is known at present, and the importance of which in the Straits of Gibraltar and in the Dardanelles is very great. Without waiting for the spring campaign the Italian government is starting work next month in the Dardanelles, at which two Spanish scientific men have been invited to assist. The first work of the spring campaign will probably be in the Straits of Gibraltar.

AN oil shale laboratory, with an initial expenditure of at least $20,000, is to be established at the University of Colorado at Boulder immediately by the United States Bureau of Mines and the state of Colorado. The laboratory is to be operated under the department of mechanical engineering, and will be under the direction of Professor John A. Hunter. The department at present maintains an oil laboratory which can be utilized to some extent in the new work. To house the machinery and equipment which will be necessary for the experimental treatment of shales a separate building will be erected. The Federal Bureau of Mines will send men to the university to look after the government's end of the work, and it is expected that eventually the department will grow to the magnitude of the radium research laboratory established several years ago at the School of Mines at Golden. The last named work at present requires the services of a dozen men and occupies a three-story building. The new department is designed for the research and experimentation consideration necessary for the exploitation of the huge deposits of oil shales in western Colorado and Utah on a commercial basis.

THE board of directors of the American Electrochemical Society has approved and ordered sent to members of Congress and the officials of the War Department the following resolution concerning the Chemical Warfare Service:

WHEREAS, The development of science and research is of paramount importance not only to the military establishment of the United States, but to the welfare and security of the entire nation; and

WHEREAS, The bill introduced into Congress for the reorganization of the Army (Senate 2171—66th Congress) is not only clearly destructive of the Chemical Warfare Service, but is so drawn as to belittle all scientific and technical work in the Army and make it subordinate to the unscientifically trained officer:

Therefore, be it Resolved, That the American Electrochemical Society urges strongly that any legislation for the reorganization of the Army shall provide for the continuing of the Chemical Warfare Service as a separate staff bureau as at present; shall provide for the commissioning of staff officers in the corps and departments in which they are to serve; and shall in general accord to the technical man full recognition and opportunity

throughout every grade and department of the military establishment.

Arthur D. Little, Inc., chemists and engineers, Cambridge, Mass., through its Information Department, is planning a series of Bibliographic Studies, to be circulated among the public, university and special libraries of the United States, and the firms and individuals interested in the various studies. Those in course of preparation are: Chemical Warfare; Alcohol from Waste Sulfite Liquors; Industrial Research; The Automobile and Tractor at the Front; The Electric Furnace; Industrial Laboratories; Molasses; The Chemical Action of Light; Woods and Fibers used as Paper Making Materials. Copies of the first three of them are ready and may be had upon request.

The Rev. Dr. William T. Manning, rector of Trinity Parish, New York, offered a resolution in the House of Deputies of the Episcopal Church at the recent general convention in Detroit, providing for the appointment of a committee of three bishops, three presbyters, and three laymen "to consider the fuller recognition of the ministry of healing in the Church and the need of its revival under proper sanctions and safeguards." The resolution was unanimously adopted and sent to the House of Bishops for concurrence. Dr. Manning, who is a trustee of Columbia University, has been interested in an English faith healer who has held clinics at Trinity Church.

In connection with the statement issued by the United States Public Health Service in regard to the probable return of the influenza epidemic this year, it is announced that the laboratories of Harvard University have been chosen to conduct exhaustive research into the causes, effects and complications of the disease, together with their prevention and cure. Dean David L. Edsall, of the Harvard Medical School announces that a large corporation which suffered losses as a result of the epidemic last year has given $50,000, the greater portion of which will be used by Dr. Milton Joseph Rosenau, professor of preventive medicine and hygiene of the Harvard Medical School and a corps of assistants to carry on the exhaustive studies and research to discover some means to prevent future outbreaks of the epidemic.

It is stated in *Nature* that under the will of the late Dr. Joseph Wiglesworth, his ornithological library passes by bequest to the University of Bristol. This library of more than 1,000 volumes, including finely-bound copies of the works of Gould, Seebohm, Dresser, Lilford, Levaillant and other leading authorities, is probably one of the best in England. It will be housed in a separate room in the new university buildings, and will be kept up to date. Dr. Wiglesworth gave the residue of his estate to the university after his widow's death for the furnishing and maintenance of this special library.

UNIVERSITY AND EDUCATIONAL NEWS

At the recent meeting of the Yale Corporation several gifts were announced. Mr. Austin C. Dunham, of Hartford, has given $64,000 to cover the amount advanced by the Sheffield trustees in constructing the electrical engineering building of the Sheffield Scientific School. The building is to be known hereafter as the Dunham Laboratory of Electrical Engineering. By the death of the widow of Dr. Levi Shoemaker, of Wilkes-Barre, property valued at about $200,000 goes to the university for the general endowment of the School of Medicine. A fund of $6,000 has been received from Edith Meacham Hitchcock and Standish Meacham of Cincinnati, to establish a scholarship in the Sheffield Scientific School in memory of Robert Douglas Meacham of the class of 1907 of the Scientific School.

The sum of five thousand dollars from a "friend of the university" has been received by the University of California for the support of special research work in the department of paleontology during the year 1920.

Dr. Roswell P. Angier, professor of psychology at Yale University, has been appointed to the newly established deanship of the common freshman year.

AT the University of Manchester the following appointments have been made: A. G. Ogilvie, reader in geography; J. MacMurray, lecturer in philosophy; A. Gardner and R. L. Newall, demonstrators in anatomy.

DISCUSSION AND CORRESPONDENCE

A PROPOSAL OF TWO NEW MIOCENE FORMATIONAL NAMES

IN the summer of 1916, I organized, with the help and encouragement of Professor G. D. Harris, a paleontological expedition to Santo Domingo, with the hope of differentiating the Yaqui Valley Tertiary beds. These had been indiscriminately called Miocene by Professor Gabb in 1874, and in recent years referred by Dr. Dall and Dr. Pilsbry to the Oligocene. The members of the exploratory party were Mr. Karl Paterson Schmidt, Mr. Axel Olsson and the writer, the actual collecting being very efficiently done by the two gentlemen. The collections were chiefly made from bluffs along tributary streams flowing northward through the Samba Hills into the Rio Yaqui. Our most important collections and sections were made on the Rio Cana near Caimito, the Rio Gurabo near Los Quemados, and the Rio Mao near Cercado.

While proceeding up the Rio Gurabo, Mr. Schmidt and Mr. Olsson observed a sudden change in the fauna of the bluffs near Los Quemados. They felt confident that this indicated a different formation from that further down the stream.

A careful and detailed study of the mollusca we had collected was made by the writer and the presence of two formations verified, the results being published in 1917.[1] I then designated these two formations by index fossil names, calling them the Lower or *Aphera islacolonis formation*, and the Upper or *Sconsia lævigata* formation.[2] This was to contrast them with the *Orthaulax inornatus* formation. I referred the *Orthaulax* formation to the Upper Oligocene of Tampa; the Lower or *Aphera* formation to the Lower Miocene; and the Upper or *Sconsia* formation to the Middle Miocene.

It now, however, seems desirable to apply geographical names, in conformity with modern stratigraphical nomenclature, to these formations. I therefore propose for the Upper or *Sconsia lævigata* formation of my 1917 report, the name Gurabo Formation. This includes primarily our Zones A to F on Rio Gurabo near Los Quemados and our Bluff 1 on Rio Mao near Cercado. For the Lower or *Aphera islacolonis* formation of my 1917 report I now propose the name Cercado Formation. This includes primarily our Bluffs 2 and 3 on Rio Mao near Cercado, our Zones H and I on Rio Cana near Caimito, and our Zone G on Rio Gurabo near Los Quemados. The Cercado formation also includes a set of fossils from Bulla river loaned to me for study by the American Museum of Natural History.

CARLOTTA J. MAURY
PALEONTOLOGICAL LABORATORY,
CORNELL UNIVERSITY

[1] Bulletins American Paleontology, Nos. 29 and 30.

[2] *Bull. Amer. Pal.*, No. 30, p. 40, and Correlation Table facing p. 44.

SNOW DOUGHNUTS

TO THE EDITOR OF SCIENCE: To the descriptions of snow-rollers which have appeared in recent numbers of your journal may the following be added?

During the winter of 1916–17 a heavy snow fell in Monongalia county, West Virginia, which provided for a short period an opportunity for travel in sleighs. The snow drifted to depths of several feet in places and formed along some roadside fences steep-walled drifts which were, here and there, overhanging at their tops. The writer traveled in a sleigh for several miles along the side of Chestnut Ridge, the westernmost of the Allegheny Mountain ridges in this region. The snow was at this time fresh and unpacked.

At the foot of these steep-walled drifts and also lying part way down their slopes were, in many places, numbers of small snow rings resembling doughnuts in appearance. The rings were a little slenderer than the average

doughnut and the writer's impression is that they were from two to four inches in diameter and about a half inch in thickness. Each had left behind it a track in the snow which led from the foot of the overhanging portion of the drift wall down its side into or nearly to the road. A few curved, columnar pieces of snow were also found which had fallen from the top of the drift and had rolled down the side without forming rings.

It was evident that the rings and columnar pieces had been formed from small tongues of snow which had been built out over the steep side of the drift at its top by the wind. These tongues had separated from the snow wall first at the top and had bowed themselves over until their free ends nearly or quite touched the snow at their bases with the result that they broke away and rolled down the bank.

As in the case of the attainment of large size by the "rolls" described by Karl M. Dallenbach in your issue of October 17, so in this instance the completion of the ring form was a matter of balance during the process of bending forward and rolling down since a few fragments had broken away and rolled on their sides without having attained the ring form.

While the wind seems in this case to have operated in building out the tongues of snow until they became too heavy to maintain their equilibrium it was probably not involved in the rolling process which seems to have been due altogether to gravitational attraction.

W. Armstrong Price
West Virginia Geological Survey,
Morgantown, West Virginia

VARIATION OF FISHES ACCORDING TO LATITUDE

To the Editor of Science: In the number of Science for April 4, Professor Starr Jordan discusses the generalization that in certain families of fishes species living in cold waters have a large number of vertebræ, while the related ones of warm waters have a small number. He interprets this as being the result of a general phylogenetic process which is favored either in warm or in cold water, depending upon whether the large or the small number of vertebræ is considered as more primitive. He has attempted to determine which is the more primitive by investigating the ontogeny of the metameres in *Sebastodes*, but has failed in this, because, as seems to be generally the case, the number of metameres characteristic of the adult is attained at a very early stage.

We would refer to the fact that such variations in number of vertebræ with temperature occur within the limits of a single species, as Heincke[1] has shown for *Clupea harengus*. Both sea-herring and coast-herring show a decrease in (1) number of vertebræ, (2) breadth of skull, (3) number of keeled scales, and (4) length of body, as one goes from the open ocean into the Baltic. We would suggest that this shows the adaptation of the large type with many vertebræ to water of great density (very saline and cold) during the critical and sensitive early stages of development, and of the small type with few vertebræ to water of low density (brackish and warm); that is, that certain characteristics connected with a large number of vertebræ make the young of the large type develop successfully in water of high density and that other characteristics connected with a small number of vertebræ make the young of the small type develop successfully in water of low density. The adults are comparatively hardy and able to seek water of suitable density. In the species *Hippoglossoides platessoides*, Collett[2] has shown that northern specimens have more rays in the dorsal and anal fins than have southern specimens. We have not been able to find that the individuals of this species on this side of the Atlantic have the numbers of fin rays varying according to latitude. Nor does the variation of fin rays correspond with the temperature or density of the bottom water in which the adults live. There are however indications that it corresponds with the density of the surface water in which the

1 "The Natural History of the Herring," 17th Ann. Rep. Fishery Board for Scotland, 1899, p. 282.

2 "Fishes," Norweg. North-Atlant. Expedn., Zoology, Vol. III., 1880, p. 148.

eggs develop. A fruitful field for investigation is open in this direction.

A. G. HUNTSMAN

CONSTANTS AND VARIABLES IN BIOLOGY

TO THE EDITOR OF SCIENCE: I have read Mr. Frank J. Kelly's letter on the substitutes for the words "homozygous and heterozygous." His argument appeals to me very particularly because we are constantly confronted with variously constructed new terms to express scientific theories. It seems to me it is by far best to give a special and restricted meaning to the ordinary words of the English language as is done in mathematics.

In this science the word "constant" is used to express a stable quantity and "variable" one that is subject to change. Why could not these two terms be bodily lifted from mathematical language into biological? The second term would quite adequately cover what Mr. Kelly calls "inconstant form."

J. R. DE LA JORRE BUENO

SCIENTIFIC BOOKS

Animal Parasites and Human Disease. By ASA C. CHANDLER, M.S., Ph.D., Instructor in Zoology, Oregon Agricultural College, Corvallis, Oregon. xiii + 570 pages. 6 × 9. 254 figures. Cloth, $4.50 net.

The work aims to present the subject of parasitology and especially its relations to the problems of human disease in such form as to make it attractive to the generally educated reader, and also useful to those less technically trained persons who have reason to utilize information in this field. The author's efforts have certainly achieved a good measure of success. His style is attractive and his presentation clear and reasonably complete. The work will be used by many who would not be inclined to refer to a more extended and more critical presentation of the subject.

After an introduction, outlining the significance of the subject and a discussion of parasitism in general, the first part of the work is devoted to a consideration of protozoa. These organisms have been grouped according to their systematic relationships. Under each heading, however, the particular organism is treated with reference to its significance in producing disease. The chapters included in this part are entitled: Introduction to Protozoa, Spirochætes, Leishman Bodies and Leishmaniasis, Trypanosomes and Sleeping Sickness, Intestinal Flagellates and Ciliates, Amebæ, Malaria, Other Sporozoa, and Obscure or Invisible Parasites.

This is the largest and certainly the most valuable part of the work, for it brings together a mass of material not readily available in this form in any other work. It points out in striking fashion the significance of recent discoveries concerning protozoa and disease. On the whole the treatment is well balanced and there are no important omissions. The author has included studies of recent date and perhaps has gone to the extreme in giving a place to discoveries so recent that their significance might well be considered doubtful, even if the observed facts are conceded to be correct. As an example of this may be cited the entry, in a note at the end of the chapter on spirochætes, of a discovery of one of these organisms in the kidney in cases of typhus and the comment that certain other bodies possibly are stages in the life history of the organism. One may reasonably doubt whether such conjectures regarding a complex and difficult field are really in place in a brief discussion intended to give the general reader clear and correct views of the present status of knowledge on these questions. It is only necessary to recall the number of organisms that have been at times supposed to be "causes" of certain diseases to see the questionable advisability of listing such suggestions before they have been thoroughly tested by other investigators.

Part II. on the Worms can not be regarded as equally successful. The chapters included in this part are entitled: Introduction to the "Worms," The Flukes, The Tapeworms, Hookworms, Other Intestinal Roundworms, Trichina Worms, Filiariæ and Their Allies, Leeches.

The material called for here is really better

worked up and better known and yet its presentation in this work leaves much to be desired. The author's discussion of the zoological significance of the term "Worms" is hardly on a level scientifically speaking with the work in other sections of the book. Furthermore it has no particular place in a treatise of this character where the parasitic organisms related to human diseases are the only ones under consideration. These are easily classified in certain generally recognized branches or subdivisions of other rank; they can be reasonably clearly defined without a discussion or even mention of those groups of uncertain relationships that make the subdivision of "worms" so difficult to handle. The introduction of this material serves also to confuse the student of health problems for it can hardly be intelligently handled by any one without considerable technical training in zoology. The general discussion of the significance of the parasites in this group is clearly inferior to that which has been printed in recent works like Braun or Fantham, Stephens and Theobald. The treatment of the separate subdivisions of this topic, while interesting and fairly complete, has not reached the standard set by the author in the first section of the work.

Part III. of the book is devoted to the Arthropods. After an introduction covering general features chapters are devoted to mites, ticks, bedbugs and their allies, lice, fleas, mosquitos and other blood-sucking flies, fly maggots and myiasis. The importance of these forms as agents in the transmission of diseases and their relations to specific maladies are clearly presented. The work will be a most convenient compendium despite the appearance of several recent more comprehensive works on medical entomology that cover in fact the same field as this section of Dr. Chandler's book.

It is difficult to agree with the author in his total elimination of references to those investigators who are responsible for the work outlined in the various parts of his book. While it may be true that extended references to original sources are out of place in so brief a presentation as his, yet it does injustice to the student if to no one else, that the author should present even a brief statement of the problem without any indication of the place in which the student interested can follow up the subject. I should not neglect to state that the author has included at the close of his book six pages of general references under the heading "Sources of Information." The list is very short and by virtue of the contractions employed might be difficult for some persons to use, while at the same time it is certainly unattractive in appearance on that account. Furthermore, there is no indication whatever of the significance of individual items beyond that contained in a very general subheading. In the opinion of the reviewer such a list is of very little use to the general student, and the same amount of space devoted to a citation of the major sources of information would have been of real value if the items had in one way or another been brought into definite connection with the specific discussions of the text.

The author's figures are not always particularly happy and some of them, such as Figs. 13 and 109, are little more than caricatures. It is difficult to believe that as good a scientific investigator as Dr. Chandler should have prepared a drawing like that represented in Fig. 120, where the size of the young trichinæ in the muscle fibers is apparently radically unlike the conditions as reported by many competent observers. Some of these little defects may be due to the rapidity with which the work was prepared. It is to be hoped that they can be corrected in a later edition. Many persons will find the book both interesting and useful, for it covers the field in a way not otherwise available.

Henry B. Ward

University of Illinois

THE TENNESSEE ACADEMY OF SCIENCE

The eighth annual meeting of the Tennessee Academy of Science was held on November 28, 1919, at George Peabody College for Teachers,

Nashville, Tenn., President L. C. Glenn presiding. The program of papers was as follows:

Memorial sketches of Dr. Brown Ayres and Professor Samuel M. Bain, by Dr. C. H. Gordon.

Annual address of the president, "Geography of the North Carolina-Tennessee boundary line," by Dr. L. C. Glenn.

"Recent oil and gas development work in Tennessee," by Wilbur A. Nelson.

"Luck," by Dr. F. B. Dresslar.

"The elimination of errors in a mental maze," by Professor Joseph Peterson.

"Archeology: new discoveries in the middle south," by W. E. Myer.

"Notes on the early history of the development of the mineral kingdom," by A. W. Evans.

"The feeding of the American army and some civilian applications," by Dr. Lucius P. Brown.

"Some entomological problems," by A. C. Morgan.

"Remarks on the orthoptera of Clarksville, Tenn.," by Henry Fox.

At the conclusion of the president's address a committee was appointed to recommend to the academy at its next meeting the adoption of a general name for the mountains of the Tennessee-North Carolina boundary line, taking into consideration all the different names that have been used and selecting the most authentic. This committee consists of Professor A. E. Parkins, of the department of geography, Peabody College; Dr. C. H. Gordon, of the department of geology, University of Tennessee, and Mr. Wilbur A. Nelson, state geologist of Tennessee.

The election of officers for the ensuing year resulted as follows: *President,* Dr. L. C. Glenn, Vanderbilt University, Nashville, Tenn.; *Vice-president,* Miss Jeanette M. King, Middle Tennessee State Normal School, Murfreesboro, Tenn.; *Editor,* Dr. C. H. Gordon, University of Tennessee, Knoxville, Tenn.; *Secretary-Treasurer,* Roscoe Nunn, U. S. Weather Bureau office, Nashville, Tenn.

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ORGANIC DIVISION

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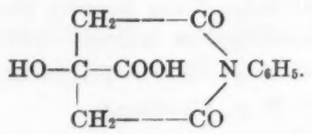
Cymene as a solvent: A. S. WHEELER.

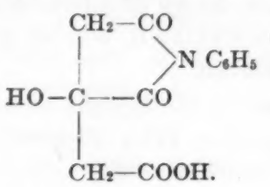
The action of basic reagents on certain Schiff's bases: A. S. WHEELER AND S. C. SMITH.

Structural problems of the aniline derivatives of citric acid: J. R. BAILEY AND E. B. BROWN. Bailey and Brown show that aniline reacts with methylene citric anhydride giving a product, which readily hydrolyzes with the elimination of formaldehyde and which the method of formation and analysis show to be citranilic acid constituted as follows:



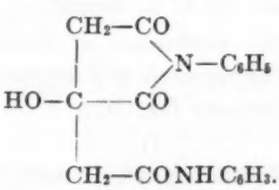
I.

This citranilic acid is a different product from a citranilic acid reported by Pebal,[1] which results from heating the mono-aniline salt of citric acid. With the constitution established for the Bailey-Brown citranilic acid, there remains only the isomeric structure for the Pebal compound, to wit,



II.

This investigation also establishes the constitution of Pebal's "Citrobianil"[2] as



III.

The anilanilde isomeric with III. can be made from citranilic acid I. The proof of structure of the two aniline derivatives of citric, II., and III., is typical of the theoretical deductions to be made concerning a number of correlated substances, the structures of which prior to the investigation of Bailey and Brown were in doubt. The detailed results of this work, when completed, will be submitted to the *Journal of the American Chemical Society* for publication.

The synthesis of capric acid: G. D. BEAL AND J. B. BROWN.

The action of phosphorus trichloride on ketones and aldehydes: JAMES B. CONANT AND A. D. MACDONALD.

Condensation of acetylene with benzene and its derivatives in the presence of aluminum chloride: OTTO W. COOK AND VICTOR J. CHAMBERS. Benzene, in addition to sym. diphenylethane and traces

[1] Ann., 82, 92 (1852).

[2] Ann., 82, 87 (1852).

of styrene[3] produces 9, 10-dimethylanthracene-dihydride. Toluene gives xylene, mesitylene, pseudocumene, ditolylethane, and 2, 7-dimethyl anthracene with some 2, 6-dimethyl and beta monomethyl anthracenes. Chlorbenzene produces p, p-dichlor diphenylethane and at least one higher compound as yet unidentified. Nitro benzene does not condense. The investigation is being continued.

The structure of azoxy compounds: Oliver Kamm and E. E. A. Campbell.

The purification and some physical properties of some aliphatic alcohols: R. F. Brunel.

The limit of esterification of certain aliphatic alcohols and acids: R. F. Brunel and Elsie Tobin.

Schiff bases and related compounds: William J. Hale.

The oscillation theory of colors—hydrazobenzene and azobenzene: Gerald L. Wendt, Ruth O'Brien and F. W. Sullivan.

The chemistry of the heptane solution: (I.) Introductory remarks; (II.) Physical constants of heptane: Edward Kremers.

The chemistry of the heptane solution: (III.) Purification of heptane; (IV.) Hydrohalogen solutions of heptane: D. C. L. Sherk.

Report on the production of synthetic organic chemicals in the research laboratory of the Eastman Kodak Company for the year 1918–19: C. E. K. Mees.

Perchlormethylmercaptan: Oregon B. Helfrich and E. Emmet Reid.

Butyl alcohol as medium for saponification: A. M. Pardee, B. Hasche and E. Emmet Reid.

Halogen-substituted phenacyl bromides as reagents for the identification of acids: W. L. Judefind and E. Emmet Reid.

Molecular rearrangement in the acylation of certain aminophenols: L. Chas. Raiford. In the preparation of diacylated derivatives of certain ortho-aminophenols, in which the acyl radicals bound to oxygen and to nitrogen, respectively, are different, it has been found, upon examination of the products, that the heaviest of these radicals was always found attached to nitrogen, regardless of the order in which they were introduced, which indicates a rearrangement in one case. The acyl radicals so far employed are acetyl and benzoyl, and the bases tested are 2-aminophenol, 2-amino-4-methyl-6-bromophenol, and 2-amino-4, 6-dibromophenol. Apparently the presence of an acid-forming substituent in the aminophenol does not change the course of the reaction.

A more nearly rational system of units: Elliott Q. Adams.

Certain metallic derivatives of hydroxy-anthraquinones: M. L. Crossley.

Pyrogenic conversion of phenol to napthalene: M. L. Crossley.

Reduction of dihydroxythymoquinone by means of palladium-hydrogen: Nellie Wakeman. Dihydroxythymoquinone, in alcoholic or ethereal solution, reduced by hydrogen in the presence of finely divided palladium, loses its red color, the solution becoming colorless. Upon evaporation of the solvent, in contact with air, the color returns and red crystals of dihydroxythymoquinone result. Evaporated in an atmosphere of hydrogen, flaky white crystals are obtained. These, upon exposure to the air, change to red dihydroxythymoquinone. Reduced in the same way in acetic acid anhydride solution, dihydroxythymoquinone yields a tetra-acetyl derivative which is stable in the air, and separates in colorless prismatic crystals melting at 180°–182°.

Congo red and some similar disazo-dyes: W. R. Orndorff and F. E. Carruth.

Synthesis of anthracene from naphthalene: C. W. Colver and W. A. Noyes.

Positive iodine in derivatives of acetylene: L. B. Howell and W. A. Noyes.

The attraction between organic substances and water, and the adsorption of organic substances: W. D. Harkins.

Determination of the viscosity of pyroxylin solutions: E. F. Higgins and E. C. Pitman. (By title.)

Charles L. Parsons,
Secretary

(To be continued)

[3] Varet and Vienne, *Compt. Rnd.*, 164–1375.

SCIENCE

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IN PREPARATION

Vertebrate Zoology

By HORATIO H. NEWMAN, Ph.D., Professor of Zoology and Embryology in the University of Chicago. Octavo, Illustrated, xiii+432 pages. *To be published in January.*

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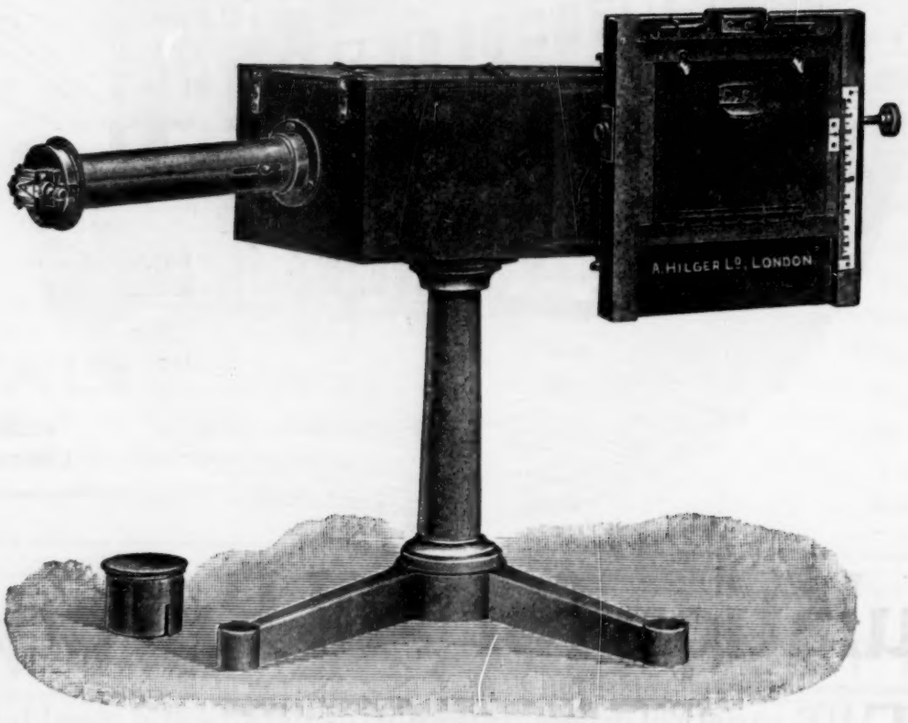

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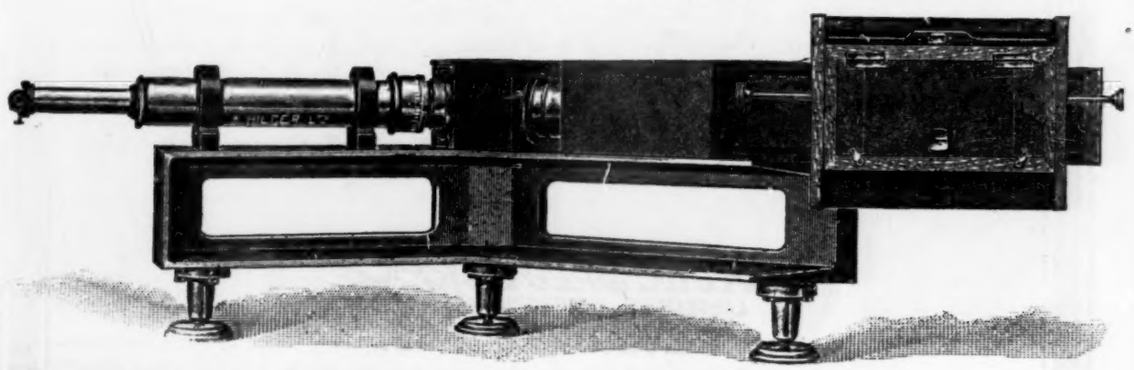

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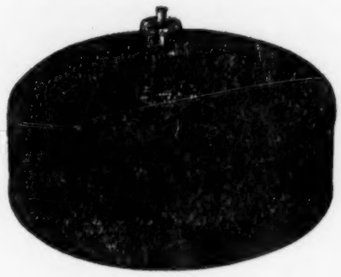

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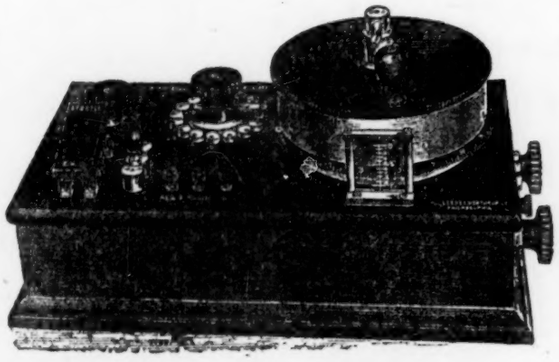

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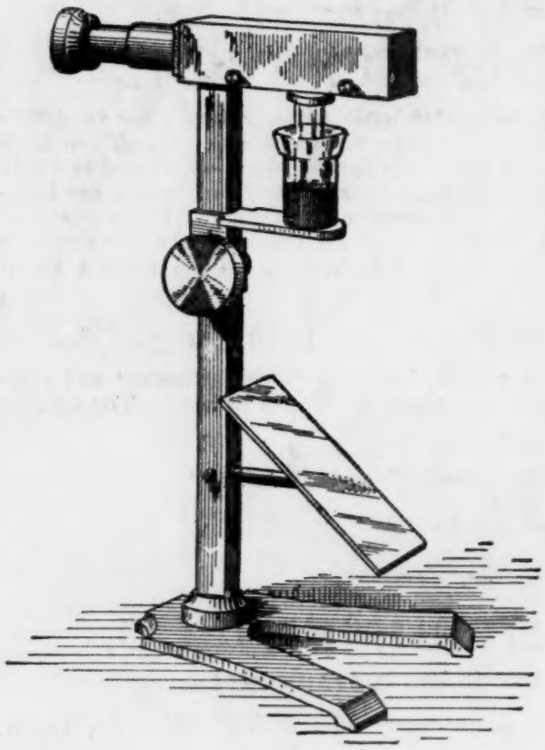

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